Kravcik M., Kaibel, A., Specht, M., and Terrenghi, L. (2004). Mobile Collector for Field Trips. *Educational Technology & Society*, 7 (2), 25-33.

Mobile Collector for Field Trips

Milos Kravcik, Andreas Kaibel, Marcus Specht and Lucia Terrenghi
Fraunhofer FIT Institute for Applied Information Technology
Schloss Birlinghoven
53754 Sankt Augustin,
Germany
Tel: +49 2241 142928
Fax: +49 2241 142146
Milos.Kravcik@fit.fraunhofer.de
Andreas.Kaibel@fit.fraunhofer.de
Marcus.Specht@fit.fraunhofer.de
Lucia.Terrenghi@fit.fraunhofer.de

Abstract

Current e-Learning is based on learning management systems that provide certain standard services - course authoring and delivery, tutoring, administration and collaboration facilities. Rapid development of mobile technologies opens a new area of m-Learning to enhance the current educational opportunities. Field trips are a relevant part of the curriculum, but for various reasons it is often difficult to organize them. The aim of the RAFT project is development of a system that would enable virtual field trips. One mobile learning application prototype created in this project, called Mobile Collector, enables data gathering and annotation in the field, together with real time collaboration. The application supports learner-centred education in real world context.

Keywords

Collaborative learning, Constructivism, Mobile learning application, Virtual field trips

Introduction

Modern e-Learning is based on the Internet infrastructure, hypermedia technology, advanced graphical user interface, sophisticated communication and cooperation services. Standard formats enable interoperability and reusability of resources, searching is supported by means of metadata. Instead of the traditional behaviouristic approach in education more attention is given to cognitivism and constructivism. Learning management systems represent the main platform for e-Learning providing various facilities (Maurer, 2002):

- Courseware modules - reusable, searchable, interactive, and customisable
- Authoring tools - to create and combine the modules
- Administration tools - to manage these modules and their users, to provide statistical data about them
- Tutoring tools - to provide overview on the progress of a class as well as each individual learner separately
- Communication and cooperation tools - with automatic notification, searching and filtering facilities
- Support for various learning models and styles, on different cognitive and knowledge level

Current learning management systems usually include most of these components, but they are still not adaptive enough, taking into account the student's preferences, knowledge, learning styles, objectives, interests, and other attributes. Therefore the current trend is to provide personalized adaptive learning in open and distributed environments.

Nowadays we can see a rapid development of mobile information technologies. The range of ubiquitous services is growing. Mobile systems have the potential to influence also the area of education in the near future, as they are especially popular among young people. Therefore it is a challenge for developers to offer new mobile applications that will together with entertainment provide also innovative learning opportunities. We cannot expect that m-Learning will soon substitute e-Learning as we know it today. There is still no real reason to omit powerful desktops with large screens. One should rather see mobile solutions as enhancements of the current educational technologies. We see several important new issues for mobile learning:

- "Develop-once deliver-many" idea as new authoring tools for learning content enable the authors to deliver their content in a variety of formats
- Contextualized information, delivered adapted to the current user context, where the context may include the personal preferences, the current task, the location, and the time (Abowd, Day, Abowd, Orr, Brotherton, 1997; Gross, Specht, 2002)

ISSN 1436-4522 (online) and 1176-3647 (print). © International Forum of Educational Technology & Society (IFETS). The authors and the forum jointly retain the copyright of the articles. Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear the full citation on the first page. Copyrights for components of this work owned by others than IFETS must be honoured. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from the editors at kinshuk@ieee.org.

- Direct cooperation and integration of the learning process into the learning context (Slotta, Cheng, 2001)

Modern education technologies can drive the development process in the area of pedagogy. As pointed out for instance by B. Trilling (PILOTed, 2004), our existing school system is well designed and adapted to the industrial age, when people mostly worked on manufacturing processes in a routine way. In the knowledge age the goal is to get people into the higher skilled, knowledge work jobs, demanding critical thinking, creativity, collaboration and interpretation abilities. To support the experiential and active learning (Kolb, 1984) teachers embed field trips in the curriculum. But it is often very difficult to organize meaningful field trips for various reasons, including finance, staffing levels, health and safety issues. In this area appropriate use of technology can improve and enhance educational experience of students.

The developments in wireless communication and mobile devices, the pedagogical demands for cultivating knowledge management skills and existing difficulties with organization of field trips led us and our partners in the consortium to initiate the RAFT (Remote Accessible Field Trips) project. Its philosophy is the employment of the available technology to produce an integrated and interactive system for linking, in real-time, field trips and classrooms. According to the RAFT approach only a few students go to the field and the remaining students interact in real-time with them. This should be achieved by means of web based tools, designed according to the collaborative learning principles.

The design of new applications that allow the integration of mobile interface and mobile learning processes is currently a hot topic of discussion. For example the KLEOS project looks at the temporal arrangement of learning episodes and individual learning projects, combining those with the spatial and semantic dimension of learning content and context (Giasemi, Vavoula, 2002). In most of the recent works on mobile learning, problems concerning efficiency and simplicity of use are usually mentioned. This is due to the typical constraints that have to be considered in mobile computing generally (small screens, input/output constraints, limited power and connection supply, situation of use on the fly) together with the specific issues raised by the learning objectives (the cognitive status of users, pedagogic goals of situated learning and collaborative work).

In this paper we explain the approaches of the RAFT project to augment the learning experience and then present our Mobile Collector for data gathering in real world contexts and remote collaboration, describing its functionality, design, and evaluation. Finally we provide concluding remarks and outline further development of the RAFT system.

Remote Accessible Field Trips

The RAFT project (RAFT, 2003) aims to support students in active, cooperative and sustainable learning combining classroom and on-site research. The main scientific and technological objectives of this project are to demonstrate the educational benefits and technical feasibility of remote field trips, to establish extensions on current learning material standards and exchange formats for contextualisation of learning material. This is combined with the embedding of learning and teaching activities in an authentic real world context, with real time video conferencing and audio communication to promote new forms of contextualised learner collaboration.

Investigations into the current state of field trips and the curricula in various countries show that despite the recognized educational benefits there are many limiting factors such as time in the curriculum, consent, health and safety factors, insurance and staffing. Virtual field trips provide the next best thing to actually being in the field. However, problems occur when students need personal contact with their teachers (Frank, Reich, Humphreys, 2003). The RAFT approach is to help alleviate this problem by allowing opportunities for constant communication between students and teachers.

The success of the system will depend on its educational and curricular relevance. Therefore the RAFT field trips are being developed in cooperation with practising teachers is a wide area of subjects. The learning theories most appropriate to the RAFT approach, as they consider learning as a social activity, are based on Piagetian and Vygotskian concepts. They include:

- Collaborative learning: working with peers in the classroom and in the field as well as with students from other schools or countries towards a common outcome
- Cooperative learning: a group solves a task, each member contributes to achieve the joint result (Johnston, Johnston, 1994)
- Situated learning: learning in an authentic context, practical problems are solved (Lave, Wenger, 1991)

- Peer assisted learning: two students work together for their group (Topping, Ehly, 1998)
- Vicarious learning: "meta-learning" learning by observing other groups' approaches (Lee, Dineen, McKendree, Mayes, 1999)

A key objective of the RAFT project is to enable all the participating students to be involved in the learning experience. Therefore a cooperative approach to learning has been adopted. Each student has a particular role in a group and each role has a specific task. The scope of these roles is being investigated, including the qualities developed in the pupils taking these roles (Rentoul, Hine, Specht, Kravcik, 2003).

The engineering of the RAFT client devices includes the authoring toolkit for creating contextualised learning materials, the mobile reader client for the replay of contextualised learning materials, the mobile field station for the coordination of several mobile clients, and the extension of the learning management system (LMS) for managing scheduled live interaction between remote field trip clients and classroom students. The RAFT system will integrate the LMS with customized solutions for contextualised live interaction and video conferencing. The design and implementation of different interface components for interaction with the LMS from PDA, wearable computer and the integration of live video and audio conferencing templates are the main tasks. Additionally the currently implemented metadata sets should be extended for capturing and handling additional context data about learning objects. Different functions of the proposed system in three layers (operating, servicing and enabling) are shown in Figure 1.

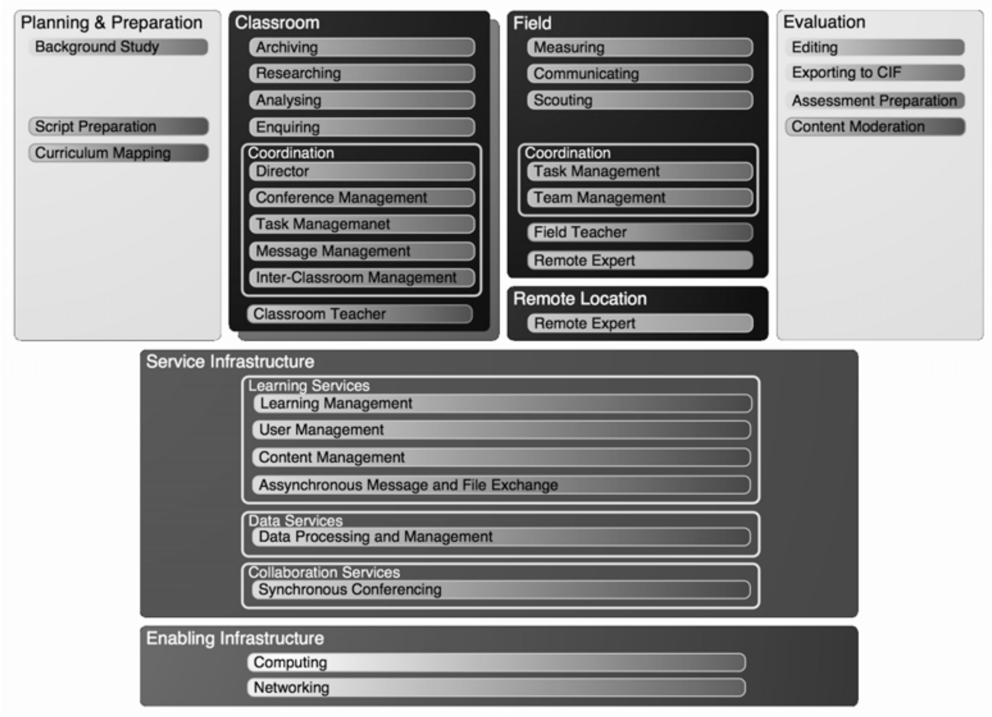

Figure 1: Functional Overview of the RAFT System

The Learning Services in the diagram are represented by the system called Adaptive Learning Environment (ALE) that has been originally developed in the WINDS project (WINDS, 2003). The system combines the functionality of an e-Learning system with adaptive educational hypermedia on the Web (Specht, Kravcik, Pesin, Klemke, 2001; Specht, Kravcik, Klemke, Pesin, Hüttenhain, 2002). In the RAFT project (RAFT, 2003) we develop ALE further so that it can support also mobile learning (Kravcik, Specht, Pesin, 2002; Kravcik, Specht, Kaibel, Terrenghi, 2003).

Mobile Collector

The basic principle of our approach is simplicity and usability regarding both data collection and annotation. As a part of a course the teacher can prepare a learning object called *field trip* which consists of several modules called *topics*. Each topic includes several *tasks* for the learners in the field. For every task a learner (or a group of learners) creates one (or more) *collection(s)* where collected photos will be placed. The pupils in the field can collect data, annotate it, and assign related metadata to it. The data is stored in such a way that later on it can be easily retrieved when needed. There is a communication channel between the field and the classroom so the learners in the school can ask questions, give suggestions to their peers outside, or help them providing useful information on demand. The Mobile Collector application should meet the following demands:

- Authoring: simple creation of learning objects related to field trips
- Data collection: possibility to collect data (especially photos) in the field and to store them into a common repository
- Data annotation: possibility to annotate (both by predefined concepts and audio) the collected data in the field in an easy way
- Data retrieval: possibility to navigate and search for the collected data so that it can be reused
- Learning objects elaboration: possibility to integrate the collected data into structured learning objects
- Protection of author rights: students can edit or delete only their own data, but they can view also the data created by their peers

Learners can capture photos directly in Mobile Collector and if they are satisfied with it they can store it into a suitable collection. The photos can be annotated directly in the field. To make the annotation process as simple as possible the learners just choose appropriate *concepts* (keywords) from a list predefined by the teacher. Additionally they can create audio annotations for the collected photos. All the users (teachers and learners) can easily find a collection of a particular learner (or group of learners) for a certain task and also all the photos associated with a particular concept. All the collected data is stored in the ALE repository and can be later elaborated by the learner as well as evaluated by the teacher. All these materials are searchable and can be used to produce flexible and reusable learning objects. In this way the learners can integrate those materials into their projects and the teachers into their courses.

In the field learners can use various types of mobile devices for collecting data. The choice depends on the objective of the particular field trip and on the available equipment. Our Mobile Collector can run on devices that can browse the Web, have access to the ALE system, render Java applets, are equipped with a camera and a microphone. The synchronous communication channel is not a part of this application and can be provided by means of third party chat or videoconferencing systems (FlashMeeting, 2003), alternatively also by mobile phones. From the demands specified earlier these technical requirements can be derived:

- Mobile Collector devices must be easy to carry, easy to handle, and independent from external power supply
- Data transmission must be real-time (to enable real-time remote collaboration)
- Data transmission should require as little bandwidth as possible (to enable the use of Mobile Collector in environments where wireless communication with only narrow bandwidth is available)

Design

In RAFT we support the idea that each role can perform specific functionalities and needs therefore a specific interface and device. This issue is even more relevant if we consider the target group, which is not necessarily accustomed with technology and should be supported in the learning activity rather than be overwhelmed with complexity. Beside the specific tasks of a role, additional factors affect the design of the application and of the user interfaces:

- Complexity of the device: a user who has to concentrate on annotation in the field needs a support for this activity and requires the device to be light and portable
- Complexity of the task: a user collecting data is already quite busy and most of her senses have to contribute to the task; in the meanwhile she has to be able to experience what is happening in the surrounding
- Complexity of the environment: a user in the field might be distracted from her task by external conditions, such as noise, or weather changes

The tablet PC provides technical and ergonomic features which are suitable for the Annotator and Data collector roles. It supports a digital camera and enables wireless communication. Besides it is portable and its size is analogue to an A4 paper notebook, which suits annotation needs. The real estate of the screen allows comfortable visualization of preview and captured images, as well as thumbnail view of collected data. Thus the device was chosen for the Mobile Collector application.

In designing the information architecture, we attempted to suit the specific issues of context of use, thus accommodating role-specific functionalities and device-specific features. In this sense the information architecture must suggest an easy access to the information that is most relevant, hiding the functionalities that are not role-specific in order to hide complexity and avoid cognitive overload. In our prototype three different layers of navigation were realized (Figure 2):

➢ Field trip structure (top left): For simplicity, the structure of a field trip has only two different levels - several *topics*, with each of them containing several *tasks*. The structure of the field trip is always shown completely; so the learners get a holistic overview.
➢ Concepts (down left): The concepts are provided by the author (teacher). Clicking on a concept shows all photos that are related to that particular concept.
➢ Modes of employment (top bar):
    - Search case base: This mode can be used for reading the topics and tasks that have been determined by the teacher and to look at photo collections that are already available. In order to have more place for displaying text and photos, the photo collection frame is not visible in this mode.
    - Contact expert: If questions arise that can not be solved in the field this should help in establishing a contact with an expert (e.g. through telephone or videoconference)
    - Document case: Here the photo collection frame is visible, thus the findings in the field can be documented.

Figure 2: Capturing a photo

To capture a photo (Figure 2) the learner uses the video preview on the right side. After pressing the *Capture* button the taken photo appears under the button. If the learner is satisfied with it, she can save it into her proper collection. In a collection each photo is shown as a thumbnail image to enable easy navigation and searching.

The learner can annotate a photo (Figure 3) after clicking on its thumbnail in the collection. Then the photo is shown in the normal size, together with all its details (topic, task, collection, title). The learner can assign the name and the related concepts (keywords) to the photo, record audio annotation, or delete the photo. Because of the difficulties with text input while on the move, the user can assign the concepts by simply checking them in a predefined list. The other pupils can view the photo together with its attributes and assigned concepts, as well as to listen to the audio annotation. The teacher can reuse the photo and integrate it into a course.

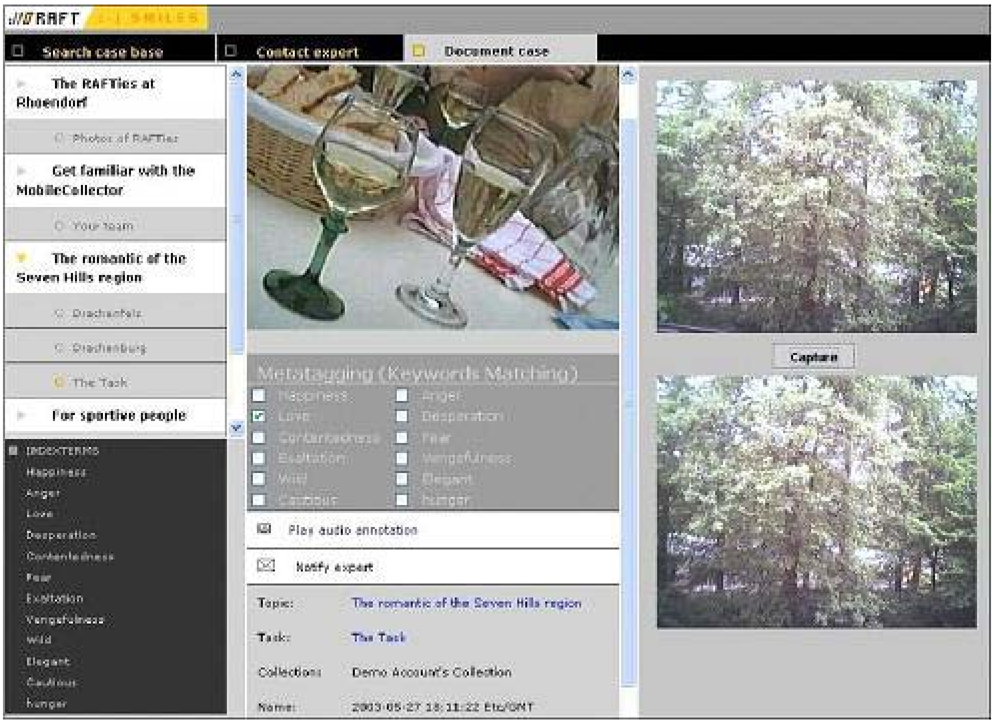

Figure 3: Annotating a photo

Evaluation

We have tested Mobile Collector twice, always with 6 girls in the age between 10 and 14, who worked with the hardware and software for two hours. For this purpose a scenario for describing and identifying different kinds of conifers has been employed. As hardware we used a tablet PC (Figure 4) with a web camera and a microphone connected for collecting data. The gathered data could then be displayed also on a notebook and on a PDA. These three devices were connected via a wireless network, with the notebook taking the role of the server.

Figure 4: Mobile Collector on a tablet PC

We assumed that the girls were not very familiar with the hardware (e.g. the handwriting recognition) and, of course, they were not familiar with the software. Therefore we planned the evaluation procedure in two steps. First they tested the hardware and software indoors to become familiar with the hardware and to learn how Mobile Collector works. To do so the following tasks were to be fulfilled:

1. Take pictures of each other and annotate them with audio and with concepts
2. View the pictures taken by the others
    a. by browsing the collections
    b. by browsing the concepts and watching the assigned photos

In the second step one group of three girls goes outdoors to collect data, the others can follow the progress by using the Mobile Viewer interface on a notebook or by using the PDA Interface on a PDA. These two interfaces have been developed just for viewing the collected data and related metadata.

All the girls were very interested in using the hardware and software. But there were differences concerning some features of Mobile Collector:

- Taking photos: The girls found taking and storing pictures very easy.
- Handwriting recognition: All students liked this feature of the tablet PC, but the software was mostly not able to recognize their handwriting. In fact Mobile Collector can be used without the need to type or write anything – the photo name is generated automatically (reflecting the date and time when the photo was taken), but can be overwritten on demand.
- Audio annotation: The girls found the process of making audio annotations very easy, but some of them did not want to do it as they did not like hearing their own voice.

In general, this experiment has shown that Mobile Collector is a tool that can be easily understood and used after a short introduction of about 30 minutes. That makes it a suitable tool for school pupils and this is the main result of our evaluation. On the other hand, we have also noticed things that have to be improved. A standard introduction course for Mobile Collector should be created. This will make the students familiar with all features of the application, it will require activity, and it should be fun. One possibility is to have the students making pictures of their peers and annotate them. Thus it is suitable to start with simple tasks in the classroom and then to continue with technically simple scenarios, i.e. indoors, with only one group of students, with good Internet connection and just few items of equipment. Possible examples include a visit of a university science lab (where only a few students are allowed to come) or in an artist's studio (where the number of students is restricted as well). As always in education the motivation is crucial and a nice end product can be a good satisfaction for the participants. We would like to emphasize the importance of appropriate hardware that can provide good visibility even in bright sunlight.

Conclusion

Mobile technologies have a potential to enhance the current educational opportunities and virtual field trips can be considered as an example. In the RAFT project we have developed prototypes to collect and annotate data on remotely accessible field trips. They open a new paradigm of learning as they enable the embedding of constructivistic learning processes in real-world contexts. This new approach is the main focus of research and development in the RAFT project.

The RAFT research deals with the investigation of the roles pupils should perform on field trips – both in the field and in the school. For these roles we currently develop a special set of tools (based on the Flash technology) that should enable pupils to perform their tasks, to collaborate and communicate with their peers. One of the primary objectives is to generate as much metadata as possible automatically, based on the current context and generated by sensors (additionally to the time parameter also other suitable attributes, e.g. GPS coordinates, temperature, etc). This will enable more precise retrieval of the data when learning objects are elaborated by students and teachers.

Acknowledgement

Remote Accessible Field Trips (RAFT) is an EU funded project in the IST programme #IST-2001-34273.

References

Abowd, G. D., Dey, A. K., Abowd, G., Orr, R., and Brotherton, J. (1997). Context-awareness in wearable and ubiquitous computing. Retrieved April 10, 2004 from http://www.cc.gatech.edu/fce/pubs/iswc97/wear.html.

FlashMeeting (2003). *FlashMeeting Video-conferencing software application*, Retrieved December 5, 2003 from http://www.flashmeeting.com.

Frank, M., Reich, N., and Humphreys, K. (2003). Respecting the human needs of students in the development of e-learning. *Computers and Education, 40*, 57-70.

Giasemi, N., and Vavoula, M. S. (2002). KLeOS: A Personal, Mobile, Knowledge and Learning Organisation System. In Milrad, M., Hoppe, U. Kinshuk (eds.), *Proceedings of the IEEE International Workshop on Mobile and Wireless Technologies in Education* (pp 152-156), Los Alamitos, CA: IEEE Computer Society.

Gross, T., and Specht, M. (2002). Aspekte und Komponenten der Kontextmodellierung. *i-com - Zeitschrift fuer interaktive und kooperative Medien 3*, 12-16.

Johnson, R. T., and Johnson, D. W. (1994). An Overview of Cooperative Learning. In Thousand, J., Villa, R. and Nevin, A. (Eds), *Creativity and Collaborative Learning: The Practical Guide to Empowering Students and Teachers*. Baltimore, MD: Brookes Press.

Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development*, Englewood Cliffs, NJ: Prentice-Hall.

Kravcik, M., Specht, M., and Pesin, L. (2002). Adaptive LMS and Mobile Learning, In Isaías, P. (Ed.), *Proceedings of the IADIS WWW/Internet 2002 Conference* (849-850), Portugal: IADIS.

Kravcik, M., Specht, M., Kaibel, A., and Terrenghi, L. (2003). Collecting Data on Field Trips - RAFT Approach, In Devedzic, V., Spector, J. M., Sampson, D. G., Kinshuk (Eds.), *Proceedings of the ICALT 2003 Conference* (pp 478), Los Alamitos, CA: IEEE Computer Society.

Lave, J., and Wenger, E. (1991). *Situated Learning Legitimate Peripheral Participation*, Cambridge, UK: Cambridge University Press.

Lee, J., McKendree, J., Dineen, F., and Mayes, T. (1999). Learning vicariously in a distributed environment. *Active Learning, 10*, 4-9.

Maurer, H. (2002). What Have we Learnt in 15 Years About Educational Multimedia, In Barker, P. & Rebelsky, S. (Eds.), *Proceedings of ED-MEDIA 2002* (pp 2-7), Norfolk, VA: AACE.

PILOTed (2004). *PILOTed Online Learning Newsletter*, Retrieved January 31, 2004 from http://www.pilotonlinelearning.com.

RAFT (2003). *Project Remote Accessible Field Trips*, Retrieved December 1, 2003 from http://www.raft-project.net.

Rentoul, R. M. S., Hine, N. A., Specht, M., and Kravcik, M. (2003). Beyond Virtual Field Trips: Collaboration and m-Learning. In Hall, R. (Ed.), *Proceedings of NAWeb 2003 Conference*, Retrieved April 10, 2004 from http://naweb.unb.ca/proceedings/2003/PaperRentouletal.html.

Slotta, J. D., Clark, D. B., and Cheng, B. (2001). Integrating Palm Technology into WISE Inquiry Curriculum: Two School District Partnerships. Retrieved April 10, 2004 from http://newmedia.colorado.edu/cscl/263.pdf.

Specht, M., Kravcik, M., Pesin, L., and Klemke, R. (2001). Authoring Adaptive Educational Hypermedia in WINDS. In Henze N. (Ed.), *Online-Proceedings of the ABIS 2001 Workshop (Adaptivität und Benutzermodellierung in interaktiven Softwaresystemen)*, Retrieved April 10, 2004 from http://www.kbs.uni-hannover.de/~henze/ABIS_Workshop2001/final/Specht_final.pdf.

Specht, M., Kravcik, M., Klemke, R., Pesin, L., and Hüttenhain, R. (2002). Adaptive Learning Environment for Teaching and Learning in WINDS, *Proccedings of the 2nd International Conference on Adaptive Hypermedia and Adaptive Web Based Systems*, Retrieved April 10, 2004 from http://winds.gmd.de/~winds/AH2002.pdf.

Topping, K., and Ehly, S. (1998). *Peer-Assisted Learning*, London & Mahwah, NJ: Lawrence Erlbaum Associates.

WINDS (2003). *Project Web-based Intelligent Design and Tutoring System*, Retrieved December 1, 2003 from http://www.fit.fraunhofer.de/projekte/winds/index_en.xml.